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Ultrasonography Superior Over Visual Assessment in Evaluation of Wound Healing After Dermabrasion

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ABSTRACT

Background: Dermabrasion as one kind of treatment for partial thickness wounds is controversial. Visual assessment as the main way to evaluate the healing process of burn wounds is also inaccurate. In this study we try to explore whether dermabrasion accelerates healing in wounds of partial thickness and determine a reliable way to evaluate epithelialization.

Materials and methods: Eight female Bama minipigs were anesthetized, and eighteen partial thickness wounds (circle, 4.0 cm^2, symmetrically located at both sides of the spine) were produced on each. Wounds on the left side underwent dermabrasion (group D), and wounds on the right side did not (group N). All wounds were covered with allogenic skin (premade). The healing processes of the wounds were observed through three different ways, which included visual assessment, ultrasonography, and histological observation. The epithelialization rate (ER) for each day was plotted together to form a healing curve, by which theoretical mean healing times could be determined ("healed" was classified as ER = 95%).

Results: Through visual assessment, the healing times of group D and group N were 13.6 and 18.0 d, respectively. Using ultrasonography, wounds of group D and group N healed at 5.0 and 10.4 d, respectively. Through histological observation, full epithelialization was seen at 5.0 d in group D and at 10.2 d in group N. The healing curves based on visual assessment deviated far from those based on ultrasonography and histological observations, the two of which were almost duplicated.

Conclusions: Earlier epithelialization could be seen in wounds of partial thickness burns after dermabrasion. It would be more accurate and reliable to monitor the epithelialization process through ultrasonography than visual assessment.

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Introduction

Targeting rapid epithelialization is important in burn wound management, especially for deep partial thickness burns. Since the beginning of the 19th century, dermabrasion has been involved in a number of conditions from skin abrasion for treating acne, pigmentation, tattoos, scars, photoaging, and other skin problems.[1] In the 1960s, Lorthior[2] first

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performed dermabrasion on burn wounds and suggested this technique be suitable for partial thickness wounds. However, even into the later half of the century, still much discussion surrounded wound dermabrasion. Supporters have reported favorable results from clinical studies[1,3-9]: wounds (mostly deep partial thickness) received dermabrasion healed earlier (2 to 3 d) compared with those treated with tangential excision or only dressing changes. However, opponents[10] were more willing to give credit to early healing due to selection bias.

Also for centuries, visual assessment has been the main way to evaluate the healing process of burn wounds. However, even experienced clinicians cannot give accurate answers of healing rate. In clinic, inaccurate assessment is harmless, but for researchers interested in burn wounds, healing time is always the key item to record. A more reliable, accurate and noninvasive method to observe the wounds' epithelialization rate (ER) is on demand.

There was a more-than-20-y experience and well-accepted protocol of wound dermabrasion in our department, and we did find huge advantages of this technique in deep partial thickness wounds: early healing, painless dressing change, and slight scar. However, owing to the inaccuracy of burn wound depth diagnosis, it is extremely difficult to perform a flawless controlled clinical trial to achieve a persuasive conclusion. Therefore, we designed this animal experiment, trying to objectively evaluate the effect of dermabrasion to partial thickness burns, by tracing the wounds' epithelialization process in multiple ways.

Material and methods

Allogenic porcine skin

According to our protocol in wound dermabrasion surgery, allogenic skin was the preferred dressing. Thus, in pilot studies, after four Bama pigs were sacrificed, their full-layer skins were flayed and produced into sterile allogenic skin dressings, according to the protocol for treating human cadaveric skin.[11]

Animal preparation

Eight female Bama minipigs (6.2-7.6 kg, 53-68 d old) were bought from Jinfeng company for experimental animals (Ji'nan, Shandong, China). After 1-wk acclimation, pigs were thoroughly washed 1 d before the experiment, followed by a 10-h fasting. All procedures of this study were in accordance with the National Institutes of Health guide for the care and use of Laboratory animals (NIH Publications No. 8023, revised 1978) and authorized by Shandong Provincial Hospital affiliated to Shandong University.

Anesthesia

Pigs were immobilized in prone position. Five milligrams of midazolam was intramuscularly administered to induce anesthesia, and sodium pentobarbital solution (3%, 1 mL/kg) was given intraperitoneally to maintain anesthesia. Heart rate and respiratory rate were also monitored.

Wound producing

After skin preparation and disinfection, 18 circles (diameter: 2.0 cm, symmetrically located at both sides of spine) were drawn on the back of each pig (Fig. 1A).

The thermal burn–inducing device (1.50 kg) (YLS-5Q; Anhui C-Com Biological Instrument Equipment Co, Ltd, Huaibei, China) was set at 75.0°C and 13.0 s (Fig. 1B), to produce wounds of partial thickness (Fig. 1C) at those circles, which had been proved by histological observation in pilot studies.

Dermabrasion

The nine wounds on the left side were then abraded (group D, $n = 9$) with the electric grinding machine (V-MAX35RV, NSK; NAKANISHI GEAR Co, Ltd, Yokohama, Japan) at 20 kr/s (Fig. 1D), until thick tiny needle-like bleeding appeared (Fig. 1E). Wounds on the right side were free from dermabrasion (group N, $n = 9$).

Coverage with allogenic skin

The premade allogenic skin was cut into small circular pieces, which were sutured onto the wounds, both group D and group N (Fig. 1F). Flurbiprofen patches (40 mg; Mikasa Seiyaku Co, Ltd, Tokyo, Japan) were also sutured at the back of the neck for analgesia. After experiment, all the animals were sent back to cages and well fed for 21 d.

Observations

Immediately after the experiment reached the 21st d, the wounds' healing processes were observed through three ways: visual assessment, ultrasonography, and histological examination.

Visual assessment

All the wounds, except for the ones destructed by biopsy for histological examination, were photographed at an interval of 24 h. All photos were blindly named, and two senior burn clinicians were asked to empirically estimate the ER of each wound (cm^2/cm^2, answer of "can't tell" was allowed). The mean of their numbers was defined as the gross photo–evaluated ER (ER-gross).

Ultrasonography

The high-frequency (13-14 kHz) ultrasonographical observations (SL3116, MyLabOne; Esaote, Florence, Italy) were made immediately after dermabrasion and at other 8 timepoints, including 1, 2, 3, 5, 7, 10, 14, and 21 d. At each timepoint, only one wound at each side of each pig was detected (2 wounds for one pig, 16 wounds in total). For each wound, the ultrasonic probe was placed over the circle center, and views of two random perpendicular directions were saved for further analysis (two pictures for one wound, 32 pictures in total). For each picture, the length percentage of the newborn epithelia (μm/μm) was defined as the ER, the mean of which was named as ultrasonography-evaluated ER (ER-ultrasonography).

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